Evaluation of Simulation Platforms for Training of Command Decision Making

Final Report

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Abstract

This report details a brief comparison that was made between two software packages, XJTech's AnyLogic and Aptima's Distributed Dynamic Decision-making, for the purpose of evaluating their suitability to microworld research related to the training of command decision-making.

Résumé

Le présent rapport présente en détail une brève comparaison de deux logiciels, Anylogic de XJTech et Distributed Dynamic Decision-making d'Aptima, qui a été effectuée pour évaluer leur pertinence comme outils de recherche sur les micro-mondes en vue de la formation en prise de décision de commandement.

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Executive summary

Evaluation of Simulation Platforms for Training of Command Decision Making: Final Report

Gerard Torenvliet; Iain Culligan; DRDC Toronto CR 2008-059; Defence R&D Canada – Toronto; March 2008.

Introduction or background: This report details a brief comparison that was made between two software packages, XJTech's AnyLogic and Aptima's Distributed Dynamic Decision-making (DDD), for the purpose of evaluating their suitability to microworld research related to the training of command decision-making.

Results: The results of our comparison indicate that XJTech's AnyLogic is a software package that is compatible with microworlds research (e.g., Gonzalez, Vanyukov, & Martin, 2005). We also found that Aptima's DDD platform could be compatible with microworlds research, but that this tool typically provides a decision-making environment that is of a higher fidelity than is typically associated with the authors' understanding of microworlds research.

Significance: This comparison can help Defence Research Development Canada – Toronto to better understand the software tools to be used in the context of Project 12sk (Accelerated Mission-based Training).

Future plans: If further comparison is required, this research is likely best extended by performing a more detailed and specific application-oriented test of both tools.

Sommaire

Évaluation de plateformes de simulation pour la formation en prise de décision de commandement : Rapport final

Gerard Torenvliet et Iain Culligan; RDDC Toronto CR AD; R & D pour la défense Canada – Toronto; Mars 2008

Introduction ou contexte : Le présent rapport présente en détail une brève comparaison de deux logiciels, Anylogic de XJTech et Distributed Dynamic Decision-making (DDD) d'Aptima, qui a été effectuée pour évaluer leur pertinence comme outils de recherche sur les micro-mondes en vue de la formation en prise de décision de commandement.

Résultats : Selon notre comparaison, Anylogic de XJTech est un logiciel compatible avec la recherche sur les micro-mondes (voir Gonzalez, Vanyukov et Martin, 2005). Nous avons aussi trouvé que la plateforme DDD d'Aptima pourrait être compatible avec la recherche sur les micro-mondes, mais que cet outil fournit un environnement de prise de décision plus fidèle que ce que qui est habituellement associé à la recherche sur les micro-mondes telle que comprise par les auteurs.

Importance : Cette comparaison peut aider Recherche et développement pour la défense Canada - Toronto de mieux comprendre les outils logiciels destinés à être utilisés dans le contexte du projet 12sk (Formation accélérée en prise de décision dynamique pour le commandement).

Plans futurs : Si d'autres comparaisons sont requises, la présente recherche sera vraisemblablement mieux poursuivie en effectuant des essais plus détaillés et plus spécifiquement axés sur les applications de ces deux outils.

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1 Introduction

Military commanders are increasingly being called upon to make decisions in complex, dynamic environments, where predicting and managing higher-order effects, making sense of large amounts of data from varied sources, and working with non-military partners with in novel cultural settings are becoming the norm. These challenges are most salient at the operational and strategic levels of military operations. However, current training of commanders in the Canadian Forces (as well as those of other militaries) focuses on tactical-level decision making, and does not fully address the complexity of decision making at higher levels. The use of microworlds, dynamic and interactive simulations of decision-making environments, shows promise to assist in training for dynamic decision making in complex systems, by capturing the essential human cognitive and decision-making elements of those systems in a simple and tractable model. Defence Research and Development Canada (DRDC) Toronto is currently performing research (Project 12sk, Accelerated mission-specific training) to test the assumptions behind the use of microworlds in training, and to develop techniques for the development of microworlds for training.

This report documents a high-level comparison made between two software tools for the development of microworld simulations, XJTech's AnyLogic and Aptima's Distributed Dynamic Decision-making (DDD), to determine their applicability to this research.

2 Method

The comparison between XJTech's AnyLogic and Aptima's DDD documented in this report was conducted using AnyLogic Advanced 6.2.1 and DDD 4.0 Service Pack 4 (which includes the Visual Scene Generator 4.0). The authors acquired the software and installed it on a typical laptop running Microsoft Windows XP Service Pack 2.

The authors reviewed the product documentation and the demonstrations packaged with each tool, and then performed a comparison of the two tools based on the following criteria:

- the capability and flexibility of the modelling languages to capture processes and dynamics at a level relevant to microworld research;
- the provision of debugging utilities to allow modellers to troubleshoot and resolve problems with model logic;
- the capability and flexibility of the simulation environments to provide user interfaces relevant to experimental investigations of human cognition and decision-making in microworld research;
- capability to develop distributed simulations where different users interact with the same model simultaneously, and communicate with each other via chat/text messages;
- the capability and flexibility of the modelling languages and simulation environments to allow for data collection pertaining to both run-time system states and user interface manipulations;
- the potential for the functionality of the simulation environments to be extended through third-party user interfaces and data collection and reduction applications; and,
- the overall usability of the simulation environments for research projects in which the model will be provided and maintained by a lead researcher (e.g., the DRDC Scientific Authority) with user-interfaces and data collection to be designed and provided by a third-party contractor.

The results of this comparison are documented in Section 3, below.

3 Results

3.1 General

This section details the results of the comparison performed between XJTech's AnyLogic and Aptima's DDD. The comparison included all of the criteria included listed in Section 2 (above) as well as other criteria deemed notable by the operators.

3.2 Comparison on Main Criteria

The table below details a comparison between AnyLogic and DDD on the main criteria introduced in Section 2 (above).

Criteria	**Comparison Details**
Capability and flexibility of the modelling languages to capture processes and dynamics at a level relevant to microworld research.	Both AnyLogic and DDD can be considered to be tools for the development of microworld simulations in that they allow for capturing a simplified set of system dynamics for the purpose of research. The chief difference between them is their intended purpose. DDD is a specialized tool for the purpose of conducting experimentation on military decision making in a tactical (or potentially, operational) environment, while AnyLogic is a tool for developing simulations of dynamic processes. AnyLogic does have the flexibility to capture a large range of processes and dynamics at a level relevant to microworld research, and its pre-packaged libraries can be extended by someone knowledgeable of the Java programming language. DDD can capture a large range of processes and dynamics, but these seem to be tailored to the geo-spatial evolution of a tactical or operational combat situation. DDD could be extended by someone knowledgeable of the C# programming language.
Provision of debugging utilities to allow modellers to troubleshoot and resolve problems with model logic.	Neither of these tools includes a debugging environment to troubleshoot problems in the semantics of their models. There is some support for troubleshooting syntax problems in each tool, and better support for this task can be achieved within a software development environment. Debugging the syntax of DDD models will likely be more difficult than for AnyLogic models, because DDD models are typically developed in a client/server architecture, so there are more potential causes for errors. In either tool, facility with the programming language on which the tool is based (Java for AnyLogic or C# for DDD) will likely be of benefit in debugging tasks.

Criteria	Comparison Details
Capability and flexibility of the simulation environments to provide user interfaces relevant to experimental investigations of human cognition and decision-making in microworld research.	AnyLogic models can be provided with simple user interfaces that use most standard Windows controls (e.g., push buttons, check boxes, text fields, etc.). More advanced user interfaces must be provided via a Java wrapper application. DDD models have a default map-based user interface, which seems appropriate to many investigations involving team work in team work in tactical situations. Custom user interfaces can be developed in C#, from which you can access the DLLs via the DDD API.
Capability to develop distributed simulations where different users interact with the same model simultaneously, and communicate with each other via chat/text messages.	AnyLogic has not been developed to be a distributed platform, but instead has been developed to allow for the modelling and simulation of system dynamics on a single platform by a single user. AnyLogic could likely be extended by the provision of custom client/server components, but this is not the designed use of AnyLogic models. DDD, on the other hand, has been designed from the ground up to be a distributed experimentation platform and so has been developed on a client/server model. Distributing models to clients is easy (each time users log into the server web page, all appropriate models are updated and readied for use), and the out-of-the-box experimental interface includes text chat with the capability for grouping operators using nets.
Capability and flexibility of the modelling languages and simulation environments to allow for data collection pertaining to both run-time system states and user interface manipulations.	Both AnyLogic and DDD allow for collecting data about the model states as they develop over time. DDD seems to include more out-of-the-box functionality for collecting data about user interface manipulations.
Potential for the functionality of the simulation environments to be extended through third-party user interfaces and data collection and reduction applications.	Both tools can be extended using their respective base programming languages to allow for the collection of complex user-interface manipulation data and data reduction. The ease of extending depends on the user's facility with these programming languages.
Overall usability of the simulation environments for research projects in which the model will be provided and maintained by a lead researcher (e.g., the DRDC Scientific Authority) with user-interfaces and data collection to be designed and provided by a third-party contractor	It is the opinion of the authors that the AnyLogic tool is best suited to a research structure in which the model is provided and maintained by a lead research and user interfaces and data collection are designed by a third-party contractor. This is because AnyLogic models seem to be more easily separable from the interfaces which operate them. DDD could also be used in an environment where the model is provided and maintained by a lead researcher, but in this case the model repository from the lead researcher's point of view would likely be a model requirements document / specification.

3.3 Other observations

In addition to the comparisons based on the main criteria, as documented in Section 3.2 (above), the authors also noted the following points of comparison:

Criteria	Comparison Details
Installation	The installation of AnyLogic is simple and straightforward. On a clean machine, the installation of DDD is similarly straightforward provided the steps in the documentation are followed. However, since DDD rests on a client/server architecture, there are installation dependencies that can be difficult to resolve.
Support	AnyLogic support is provided via email, and typically involves a 24h response cycle. DDD support is very quick and responsive, and is provided by phone or email.
Licensing	AnyLogic licenses must be activated over the internet and are linked to a specific computer (presumably by MAC address). In the DND environment it will likely require IT assistance to properly configure the firewall to allow for activation. DDD licensing is provided via a standard license code. There are no restrictions on moving licenses from computer to computer, provided the total number of seats in a given license is not exceeded. A single server license comes with four client licenses; any additional client licenses must be purchased for an additional fee.

4 Conclusions

Based on our review of AnyLogic and DDD, it is our opinion that while both tools are suitable for microworlds research, AnyLogic is most compatible with the modelling techniques currently being pursued in this research stream (e.g., Gonzalez et al., 2005). It allows for building models with simplified characteristics and dynamics that may be able to capture the cognitively relevant properties of a broad range of decision-making environments. DDD may also be useful for this purpose, but the results of our brief review indicate that DDD is tailored to making decisions in a map-based geo-spatial context. This environment is of a higher fidelity than is typically associated with the authors' understanding of microworlds research.

However, our review indicates that if the research requirement is to investigate or train team-based decision making, DDD may be the more appropriate tool. It includes a robust client/server architecture and has been developed for this purpose. AnyLogic would require significant modification and extension to scale to a client/server implementation.

References

Gonzalez, C., Vanyukov, P., & Martin, M. K. (2005). The use of microworlds to study dynamic decision making. *Computers in Human Behaviour*, *21*, 273-286.

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List of symbols/abbreviations/acronyms/initialisms

DDD. Distributed Dynamic Decision-making

DRDC. Defence Research and Development Canada

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